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Drainage and irrigation of a thirty-six square mile tract of land in Louisiana

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Drainage and Irrigation of a Thirty-Six Square Mile Tract of Land in Louisiana.

-by-

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A

THESIS

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Illustrations

Introduction

Because of the fact that I was unable to secure all of the necessary data concerning the topography of the section in question I made several assumptions. However, these assumptions were not made at random, as the land lies on the coast and is subject to the same conditions as does the southern portion of Jefferson County, Texas, of which I have accurate knowledge and which lies directly across Sabine Pass.

References:

U. S. Agriculture Dept. Bul. No. 71

" " " " " " 193

Pump Hand Book, Worthington

Drainage in La. - Chas. O. Key
Bul. No. 40

U. S. Dept. of Ag., Circ. No. 104,
Earnest Morgan.

General Description of the Territory

This piece of land is wholly within the Coastal Plain of southwestern Louisiana; bounded by the Gulf of Mexico on the south, Sabine Lake on the north and Sabine Pass on the west. The surface of Cameron County is typical of the Coastal Plain, being nearly level. The soil is alluvial. This entire tract is a salt march scarcely 1 foot above sea level and supports a heavy growth of salt or wire grass.

Notwithstanding its present low economic value, the land is very fertile and by the proper methods could be brought to a high degree of productiveness, especially in rice.

Tides

Obviously, this land is subjected to overflow due to storm tides or even daily tides between August and October. The average daily tide ranges from .5 ft. to 1.5 ft. consequently these 1.5 ft. tides flood the land while the .5 ft. tides do not. The storm tides which are much higher than the daily tides extend up into Sabine Lake through Sabine Pass. These storm tides are caused by heavy winds which blow for a considerable length of time directly on the shore. Sometimes these storm tides affect only a small part of the coast line and sometimes they extend throughout its length. The highest tide in this locality was in 1900, when the water rose 16 ft. at Galveston. The U. S. Coast and Geodetic Survey gages also show that from 1888 to 1890 there were six storm tides 2.7 ft. or more above mean low tide, and from 1904 to 1909 there were seven tides 2.5 ft. above mean low tide. The highest of these were 4.9 ft. in 1890 and 4.8 ft. in 1909. These same tides extend up Sabine Pass in Sabine Lake and consequently will affect the height of levees bordering the Lake and Pass. To protect the land from storms equal to those recorded above, all levees must be at least 5 ft. high, which is very nearly in accord with general practice in Louisiana. Because storms as severe as those of 1900 are so rare protection against them will be by insurance rather than by levees of sufficient height to prevent overflow.

Climate

The region is characterized by long warm summers and short mild winters; records showing that the temperatures rarely exceed 100°F and even then the heat is tempered by cool breezes from the Gulf, since the prevailing winds are southerly. The average annual temperature is about 68° and the average monthly temperature ranges from 52° in February to 82° in July. However, extreme variations sometimes occur; severe frosts in the winter and very hot weather in the summer for short periods are not uncommon.

Rainfall

The precipitation is practically all in the form of rain and is well distributed throughout the year. Snow occurs once in three to five years and soon disappears after having fallen. Although droughts occur, they seldom continue long and are not as serious as in regions where the level of the ground water is farther below the surace of the earth.

June and July are the wettest and October and November are usually the driest.

Rain falls about once in three days. The average annual rainfall during the past 15 years was 42.6 in. at Beaumont and 46.3 in. at Galveston, and I believe that the last figure would be safe for the territory in question. The following are a few of the notable storms in this section:

Oct. 14, 1902 . . . . 9.26 inches in 24 hrs.
Nov. 4, 1902 . . . . 6.25 "
Nov. 31, 1902 . . . . 6.87 "
June 25, 1905 . . . . 6.51 " , preceded and followed by heavy rains.

These excessive storms are of infrequent occurrence, but the records from all stations show that from 1892 to 1912 between March and October each year there occurred one or more storms of 3 to 4 inches at times when the ground was well saturated.

Project

The plan in view is to prepare the thirty-six square miles of land for the cultivation of rice. To accomplish this it will be necessary to drain the land sufficiently in time of heavy precipitation or high storm tides and to irrigate the same in time of dry weather. The canals within the levee system can be filled to within 1 ft. of their capacity by gravity under normal conditions; the water being piped from Sabine Lake. The remaining water necessary to flood the land must be pumped.

In draining, the water level within the canals can be brought down to the Lake level by gravity also; the remaining water being pumped.

Construction of Levees

Levee No. I

This levee borders the coast and should run as closely as practicable, N-60-E. It should originate at the intersection of a line drawn N-30°W approximately parallel to Sabine Pass, and the N-60°E line. The entire coastline on the Texas side is bordered by a natural sand levee about 4 ft. high, though broken at irregular intervals. Assuming that the same conditions prevail on the Louisiana side I recommend placing the levee behind this natural obstruction. I suggest this method rather than filling up the gaps in the sand levee for two reasons: 1st, the original levees are not true to direction and would leave a rough looking and patched up piece of work. 2nd, it will be necessary to dig a canal parallel to this levee and because of the irregular direction much extra excavation will be required, furthermore, the material excavated from such a canal will be sufficient to build a new levee and at the same time have the natural levee as an added protection from wave action.

Placing the levee further back will also materially reduce seepage from the sea. As staaed before, the maximum height of storm tides to provide for is 5 ft., therefore a levee 7ft. in height with a side slope of 3 on 1 and a top width of 6 ft. should be sufficient to accommodate storms 5 ft. in height.

Before any material is deposited, all stumps, logs, and other vegetable matter should be removed from the base of the levee. Then the ground should be plowed; this precaution will insure a good bond between the old and new material and also prevent excessive seepage.

The construction of a reservoir canal should be carried along hand in hand with the building of the levee as the material excavated from the canal can be used in constructing the levee. The size of this canal will be discussed later. As the material from this canal is very soft, the levee should be built in layers, giving each layer time to dry before the next is added; in this way, preventing the base from yielding as the material is added. The berm should be at least 20 ft. to insure no sliding of the canal walls and also to cut down seepage. After the levee has dried, it should be smoothed, brought to grade and the slopes planted with a vegetation such as prairie grass.

The orange-peel bucket dredge would be very suitable for this work because it could bring suitable material from below the soft surface mud and drop it from a considerable height. A hydraulic dredge would also be suitable.

Levee No. II

This levee starts at the west end of levee No.I and follows a course N-30°W for six miles. The height of water governing this levee is very similar to that of levee No.I except there will be no severe wave action. This levee will run nearly parallel to Sabine Pass and connect with levee No.I approximately one half a mile east of the jetty at the mouth of the Pass. Storm tides will back up in the Pass to maximum height of 4.9 ft. as seen before, therefore, I specify this levee to be 7 ft. in height in accord with levee No. I, having a 6 ft. width on top and a 1 on 3 side slope. The levee and reservoir canal should be built with the same precautions as levee No. I with one further precaution if necessary: at times of storm tides the outer surface of this levee will probably be wetted as much as 4.5 ft. and therefore may be subjected to some scouring action when the tide begins to recede to the sea, therefore, if this is true, I believe the cheapest method to prevent erosion would be to face the levee with coarse gravel dredged from Sabine Pass.

Levee No. III

The levee runs from the northern end of levee No. II N-60°E for a distance of six miles. This places it nearly parallel to the shore line of Lake Sabine and about 200 ft. from the water's edge. The height of this levee will be governed by the rise of water in the Lake which seldom varies more than 3 ft. in the lower reaches. However, there is a sweep of about 12 miles across the lake at this point which may, in time of high water and heavy south winds, tax the levee to some extent by wave action. The water is moderately shallow in this portion of the lake (5 - 9 ft.), consequently much of the wave action will be broken up, nevertheless, waves 4.5 ft. high may be expected in severe storms. Considering this figure, it would seem wise to raise the levee to a height corresponding to Nos. I and II, namely 7 ft., this allows at least 2 ft. for safety. This levee including the canal should be constructed the same as I and I^1 and should include facing as explained in No. II.

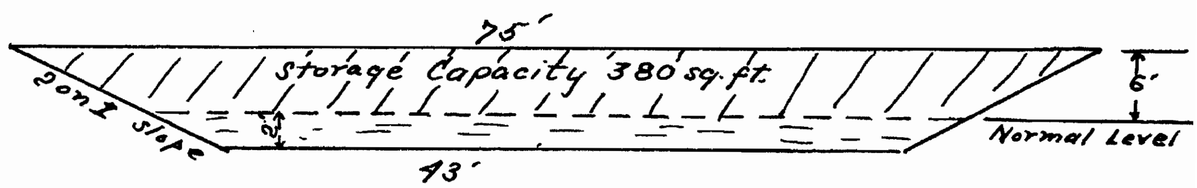
Levee No. IV.

Levee No. IV will close the tract on the east side. This structure will not be taxed with anything except perhaps overflows from the lake. Preparing of the foundation will be similar to the others. It shall be 7 ft. high.

Reservoir Canals.

A tract of land as large as this requires a very extensive system of canals. The purpose of these canals is to provide an outlet for the laterals and also to provide storage capacity. Canals follow the levees, completely surrounding the tract inside the levees. The east and west canals are connected by parallel canals spaced one mile apart. These canals are designed to carry the complete runoff of 2" over the entire area when they are filled to within 6 feet of the top. They are 8 ft. deep, therefore the water should normally be kept to a level of 2 ft. leaving 6 ft. for storage. During the drier season the level of the water need not be checked so closely but a month or so before the heavy rains start in, they should be kept to the level specified.

Two inches of water over the entire area means 165,600,000 cu ft. of water which must be carried by the canals and laterals. In the system designed we have 54 miles of storage canals and 576 miles of laterals. Therefore the sectional area required above the 2 ft. level equals 380 sq. ft. For this reason the following section was chosen:

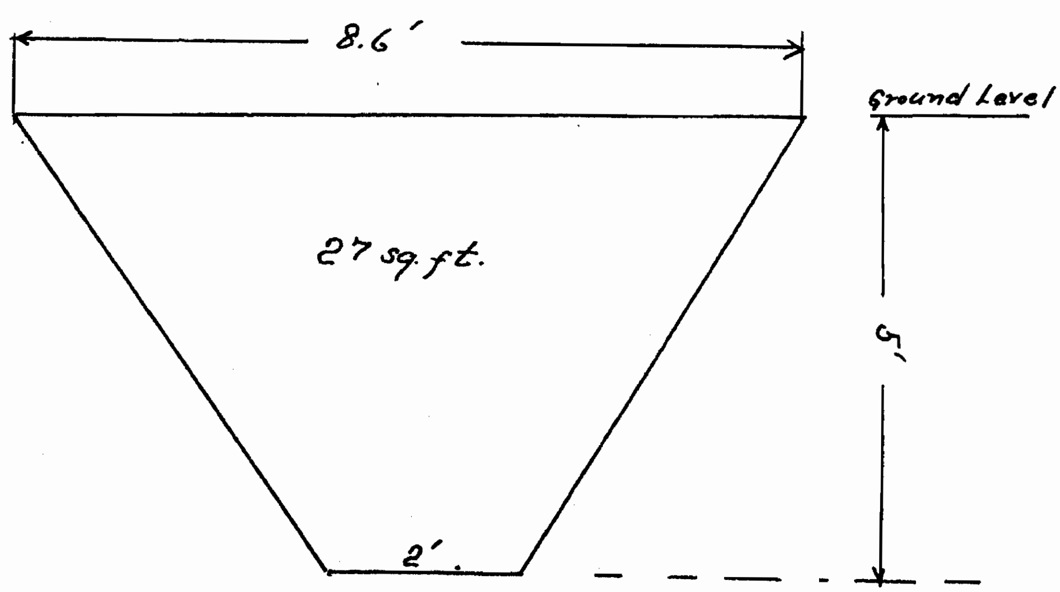


Because the excavated material is very soft, a slope of 2 on 1 was chosen. The canals can very well float a large orange-peel bucket dredge which I recommend for this work. Part of the material excavated shall be used for constructing the outer levee and the remainder for the levee between the canal and the land in question. This levee should be carried to a height of 6 ft. and the same precautions should be followed in building it as were used in the large outer levees.

Design of Laterals.

In cross sections, laterals should have a greater depth in proportion to width than larger canals. This reduces the area exposed to seepage and evaporation and also economizes in drops, bridges, and other similar structures. It also will give less encouragement to the growth of weeds on the margin and water growing plants on the bed. A slope of 1½ to 1 will be used for the laterals in question.

The capacity of laterals is affected mainly by the acreage to be served. By spacing the laterals 330 ft. apart, running approximately north and south, each lateral will accommodate 143,500 cu ft. of water from a 2" rainfall in 24 hrs. Such a quantity will require a cross section area of 26 sq. ft. The following section will give approximately 27 ft.



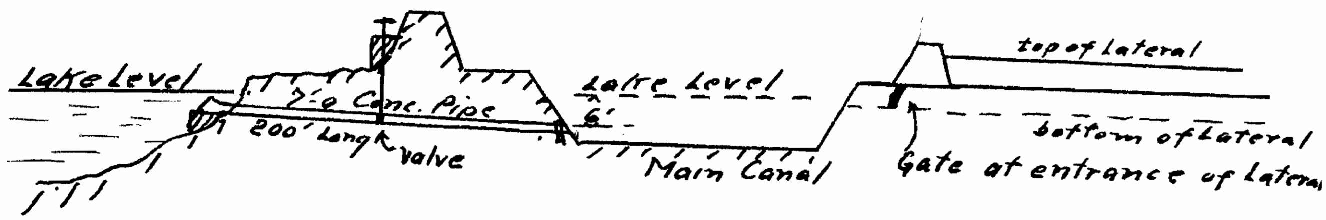
The earth excavated from these laterals shall be used to construct small levees on each side approximately 4 ft. high. A berm of about 4 ft. should be left for these levees.

At the entrance of these laterals into the reservoir canals a gate must be constructed in order to regulate the height of water in the laterals in time of irrigating. These would be best constructed of the undershot type, so as to stop as little of the sediment as may be. They will be located in the bank of the canal and the wing walls will be built so as to prevent the percolation of water around them. It will be best to provide numerous abrupt angles to prevent the passage of water around the structure, made by nailing 2 by 4 inch lumber vertically to the forms against which the concrete is poured. The earth should be carefully tamped and puddled into these corrugations.

These turnouts shall be located one ft. from the bottom of the canals in order that a supply of water may be drawn in when the canal is running at part capacity.

Gravity Feeds.

In order to reduce pumping in time of irrigation it is proposed to fill the reservoir canals and laterals as much as possible by gravity from Lake Sabine. The following calculation s were made to determine the size of pipe required to convey this water into the canals. At normal stages it is estimated that the entire system can be filled to within 1 ft. of the top of the canals.



In order to fill the canals to within 1 ft. of the top in 48 hrs., 953 cu. ft./sec of water must flow through the pipe. Calculation of the diameter of pipe:

$$\text{Diam. of pipe} \quad d = 0.4789\left[(1.5d + fl)\frac{q^2}{h}\right]^{\frac{1}{5}}$$
$$= .479\left(\frac{.02 \times 200 \times 953^2}{(6)\ \text{max. head}}\right)^{\frac{1}{5}}$$
$$= 6.8\ \text{ft. approx.}$$

∴ use a 7 ft. reinforced concrete pipe.

The outlet in the lake should be bell-shaped and be equipped with a steel grating to prevent clogging. The face of this bell should lay at an angle of 45°and not horizontal so that rubbish etcetera will slide away from the entrance. The outlet should also be supported on a concrete pillar and securely anchored to the same by means of stirrup reaching over the pipe and bedded in the concrete. There should also be at least ten cut-off walls between the lake and the levee to prevent the seepage of water along the pipe. These may be rectangular cement blocks 2 ft. in thickness and10 ft. in width. These will also serve as supports for the pipe. A regulating gate should also be placed on the outside face of the levee; a sliding gate valve is recommended. The entrance of this pipe into the main canal should be within 6 inches of the bottom and a concrete basin must be provided in order to prevent scoure of the entering water.

The system of canals as designed will drain and irrigate the land as a whole but it should be understood that a further system of sub-laterals and grading must be done when each individual 40 acres is to be cultivated.

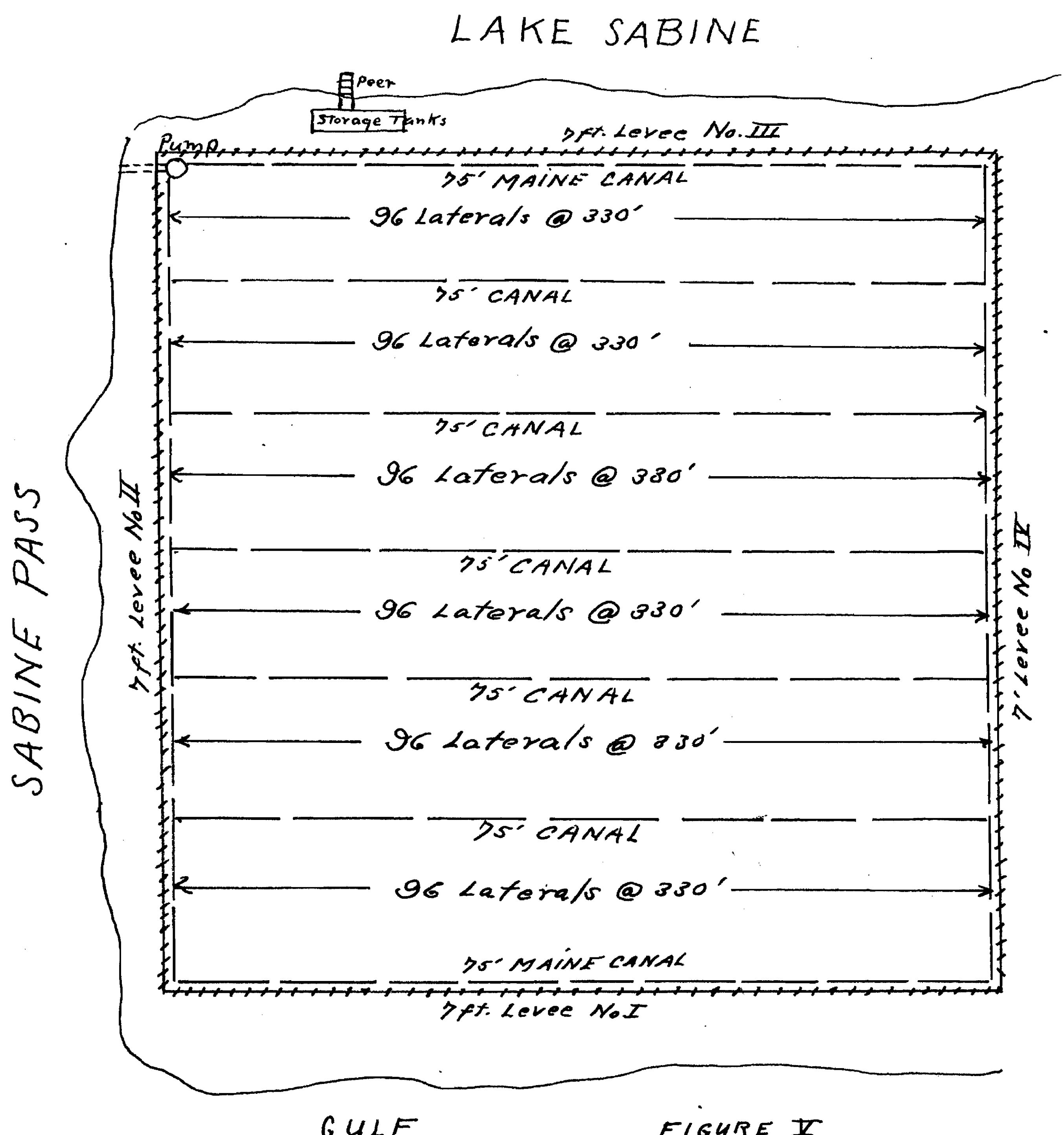


FIGURE V

Pumps and Requirements

Owing to the capacity of the project in hand it seems wise to allow pumping capacity for .75 inches in 24 hrs. To attempt to pump a larger amount would call for a large number of pumps and at this time it would be unwise to lay out as great an expenditure as would be called for.

Using a figure of .75 inches over the entire area calls for a pumping outfit of approximately 216,000 gal. per minute. For this work I recommend 10 cast iron centrifugal pumps having discharge diameters of 54 inches each. Each pump has 2 intake pipes and both the intake and the discharge pipes are tapered and enlarged to four times the area of the opening on the pump. These features will cut down the velocity head losses to about the smallest that would be economical. Since the head is approximately 7 ft. I recommend two engines of the Corliss type, having 16" x 36" cylinders for each unit. These shall be direct connected to the pumps. Return tube boilers will be used with oil as fuel.

For irrigation, the same pump may be used providing the proper method of piping is used to change the direction of flow. To do this, another set of suction pipes must be connected to the pump and running to the Lake. When these are in use, the valves in the suction pipes for drainage must be closed. Another discharge pipe must be hooked up leading into canal.

The machinery shall be mounted on a concrete foundation supported on piling. The foundation of the pumps and the engines should be constructed in one so that any settlement of either one will not throw the machinery and pumps out of line.

The building enclosing this machinery should be a steel frame, covered with heaby corrugated iron, and the plant should be of fire proof construction throughout.

The use of oil as fuel is recommended because of the proximity of large oil companies which are located at Sabine Pass and Port Arthur. Oil engines, or slow speed engines are recommended for low heads such as are encountered in this project, while electric machinery is more favorably used for higher heads and higher speed machinery.

Method of Cost Determination

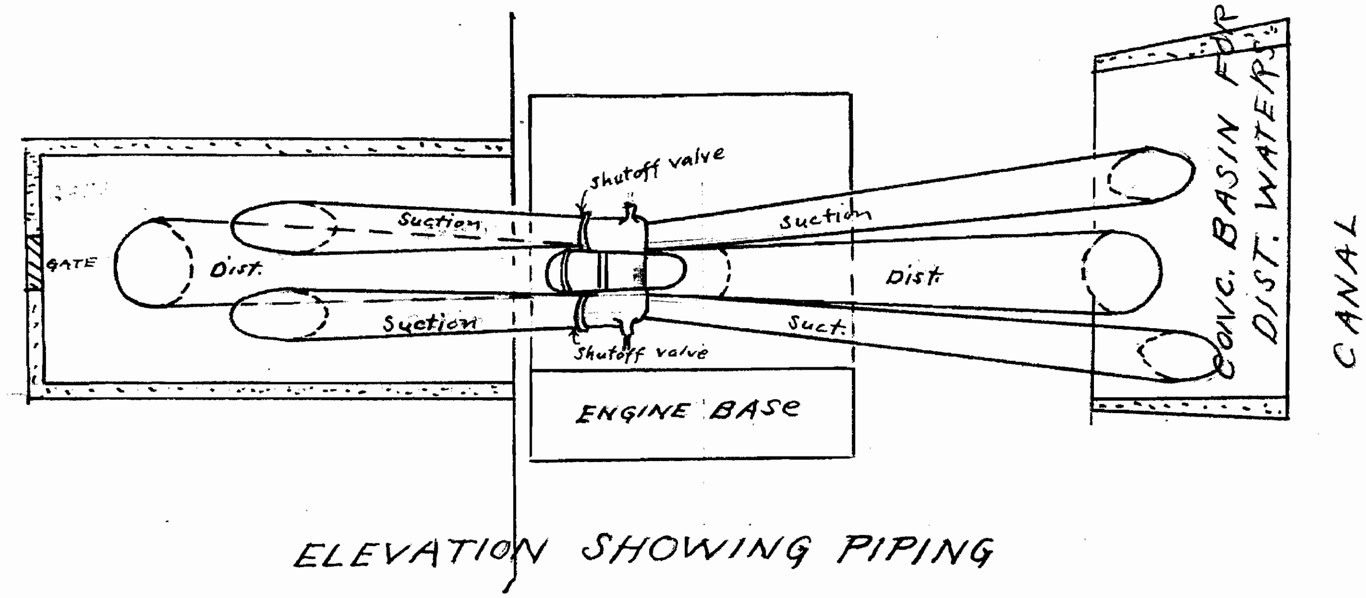
The clearing of marsh grass and a few stumps etc.is estimated to average about $5.00 per acre, there being no woodland. The excavation of ditches 8 feet or more in bottom width is estimated at 22 cents per cu. yd. and smaller ditches at 25 cents. These prices are based upon average contract prices where payment is made in cash and not in bonds. The amounts of excavation were estimated to the nearest half foot. Where the material is to be placed in a levee the price is increased 5¢ per yard to provide for smoothing the embankment.

Estimate of Cost

Clearing of land $5.00 per acre	115,200
Excavation	
(Main lands) 4,978,000 cu. yds. @ 25¢	248,900
(Laterals) 3,041,280 cu. yds. @ 28¢	851,558
200 ft. of 7 ft. diam. reinf. con. pipe	2,400
576 turnouts @ $200	115,200
Culverts and Bridges	14,800
Five complete pumping plants @ $42,000	210,000
Engineering and legal expenses, 10%	15,571
Total	$1,573,629

Acres benefitted - - 23,040

Cost per acre - - $68.30



ELEVATION SHOWING PIPING

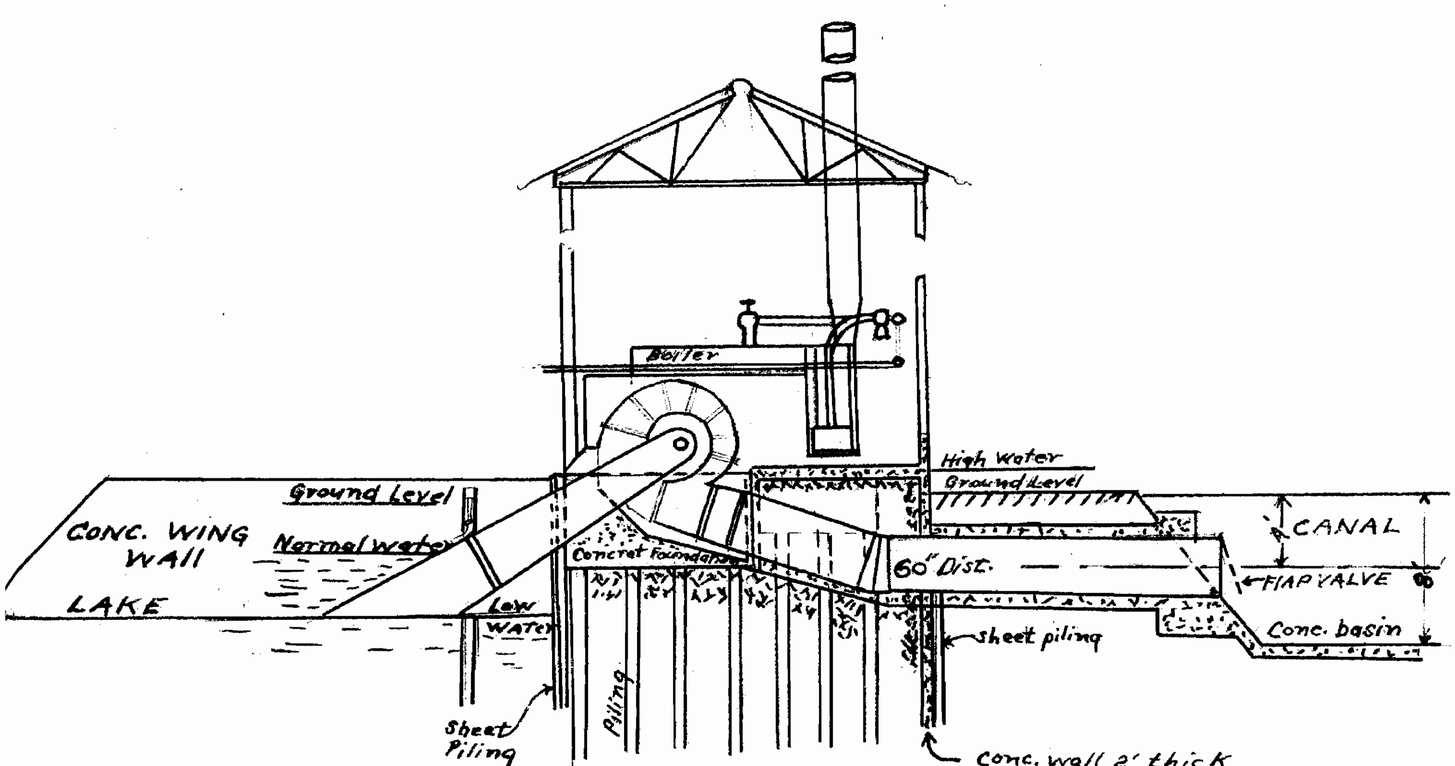


Fig II

SECTION SHOWING PUMP

Conclusion

This cost of $68.30 is prohibitive at the present time, but should a shortage of land ever come in this country this project can be carried out.